PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Application No.:	10/789,540
Filing Date:	February 27, 2004
Applicant:	Eric Sandstrom
Group Art Unit:	3609
Examiner:	Nicholas Kiswanto
Title:	CONCEPT FOR USING SOFTWARE / ELECTRONICS TO CALIBRATE THE CONTROL SYSTEM FOR AN AUTOMATIC TRANSMISSION
Attorney Docket:	DKT03066A (BWI-00084)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Supplemental Declaration Under Rule 131(a)

Dear Sir:

Eric Sandstrom, the applicant in the above-identified patent application declares as follows:

1. That on or prior to November 4, 2002, I conceived a method of calibrating a unique proportional selonoid of a unique member of a predesigned class of electrohydraulic control systems that is inclusive of at least one valve controlled by a proportional solenoid that provides an output response in response to an input current, said method comprising identifying a characteristic equation of the proportional solenoid in the electrohydraulic system, said characteristic equation including a plurality of coefficients; imbedding into a control unit for the electrohydraulic control system the characteristic equation; coupling the electrohydraulic system to a test stand; applying a

plurality of different currents to the unique solenoid of the electrohydraulic system; measuring the output response of the unique electrohydraulic system for each of the plurality of currents; identifying the unique coefficients in the characteristic equation from the output response measurements, and flashing the coefficients in a memory of the control unit of the apparatus utilized with such above noted method be shown and described in the accompanying Exhibit A including a front page, and a signature page along with a witnessing page along with additional attached pages .

2. Applicant has diligently pursued such inventive method from a date of conception on or prior to November 4, 2002 until a subsequent continuous reduction to practice filing of a provisional patent application on April 11, 2003 and a further filing of a nonprovisional application claiming the benefit of the provisional application filed on February 27, 2004 evidence (Exhibit B) of such diligence is shown and demonstrated in a copy of an e-mail sent to Johannes Braum of Volkswagon, Germany wherein coefficient data regarding the invention show in Exhibit A is given and by an accompanying Exhibit C of coefficient data regarding the invention derived on March 19, 2003.

The declarant further states that the above statements were made with the knowledge that willful false statements and the like are punishable by fine and/or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that any such willful false statement may jeopardize the validity of this application or any patent resulting therefrom.

Date: 3/31/08

Eric Sandstrom

P.O. Box 70098
Rochester Hills, MI 48326
(248) 364-4300

Respectfully submitted,

WARN PARTNERS, P.C.
Attorneys for Applicant

Dated: March 31, 2008

By:
Philip R. Warn
Reg. No. 32775

PRW:EEH:mlb

EXHIBIT A

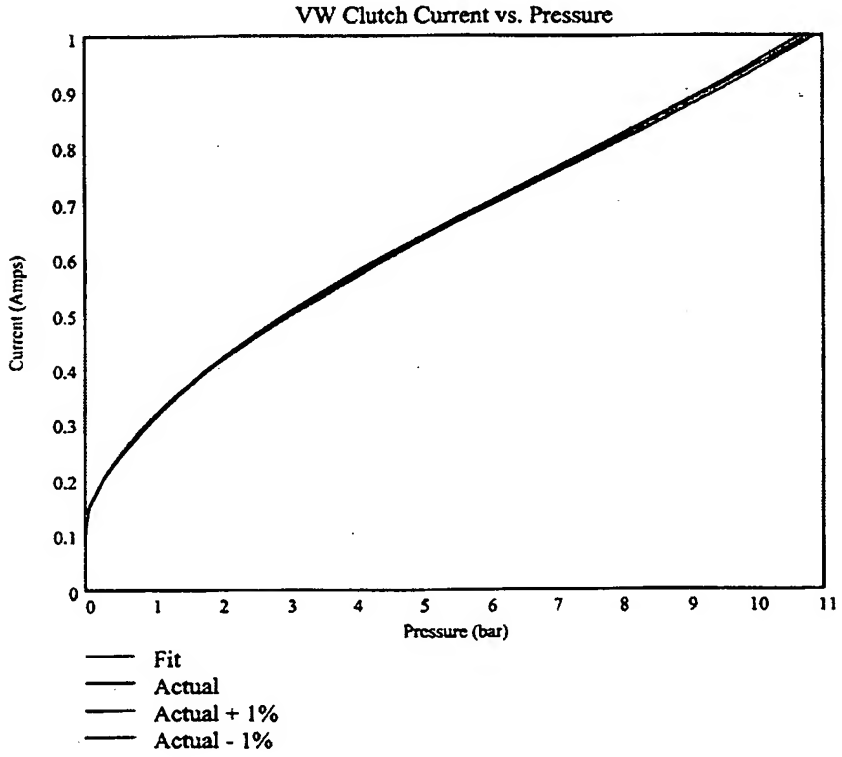
VW Clutch Pressure Calibration

E.C.Sandstrom

Characteristic Equation: $$i(P) = c1 + \frac{c2}{1 + P} + c3 \cdot P + c4 \cdot P^2 + \frac{c5}{P^3 + 0.0001}$$

Sample Equation with Coefficients:

$$i(P) := 0.376 - \frac{.242}{1 + P} + 0.059 \cdot P + 1.681 \cdot 10^{-5} \cdot P^2 - \frac{7.328 \cdot 10^{-9}}{P^3 + 0.0001}$$



VW Clutch Pressure Calibration

E.C.Sandstrom

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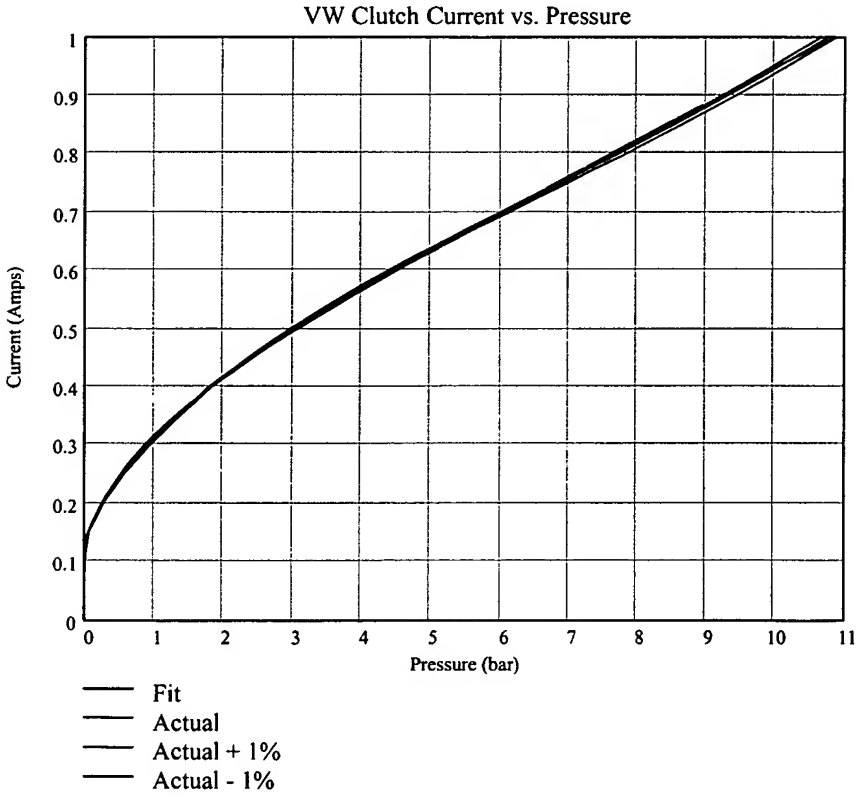


clutch.mcd

VW Lube Flow Calibration

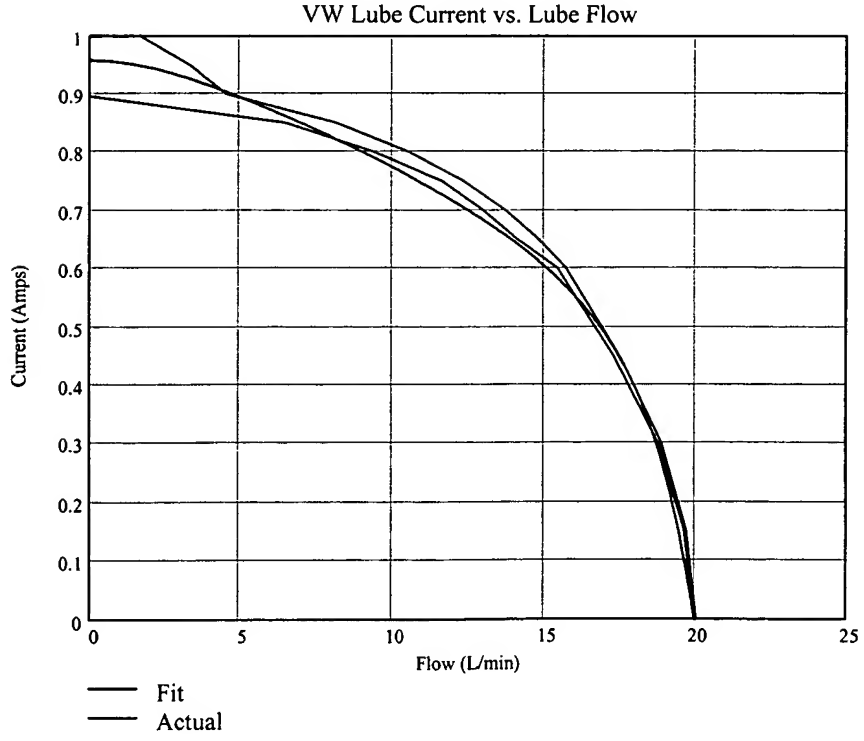
E.C.Sandstrom

Characteristic Equation: $$i(Q) = c1 + c2\cdot\left(Q^2\cdot K\right) + \frac{c3}{1 + Q^2\cdot K} + c4\cdot e^{Q^2\cdot K}$$

Sample Equation with Coefficients:

$$i(Q) := 0.834 - 0.061\cdot\left(Q^2\cdot K\right) + \frac{0.123}{1 + Q^2\cdot K} - 4.958\cdot 10^{-4}\cdot e^{Q^2\cdot K}$$

where; $K = 0.017$



lube.mcd

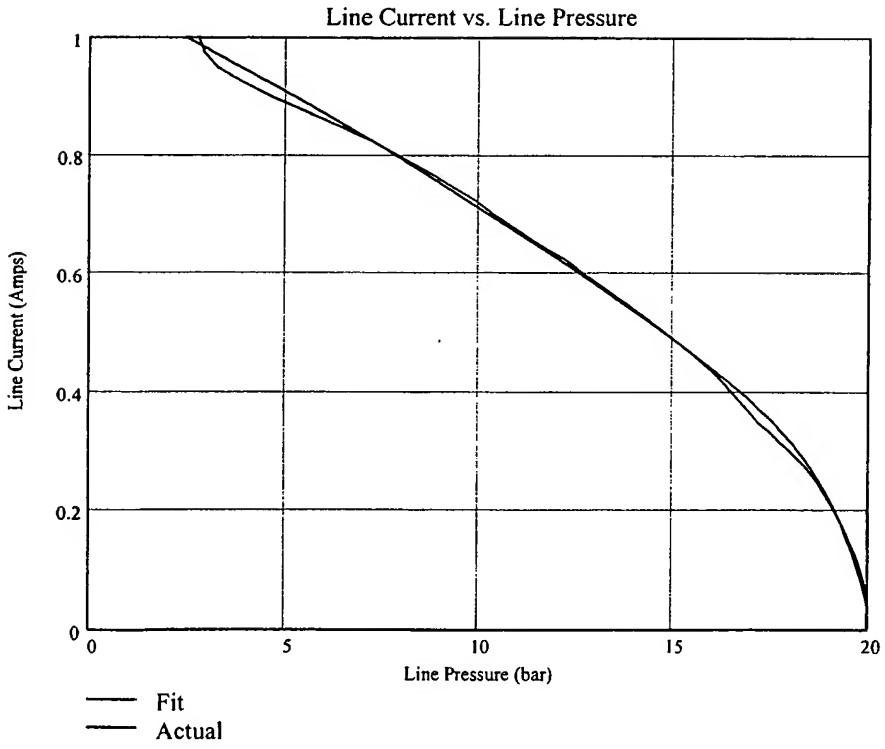
VW Line Pressure Calibration (20 bar)

E.C.Sandstrom

Characteristic Equation: $i(P) = c1 + c2 \cdot P + c3 \cdot P^2 + c4 \cdot e^P$

Sample Equation with Coefficients:

$$i(P) := 1.082 - 0.032 \cdot P + -4.906 \cdot 10^{-4} \cdot P^2 - 4.231 \cdot 10^{-10} \cdot e^P$$



lp_20.mcd

VW Cut-off Valve Calibration

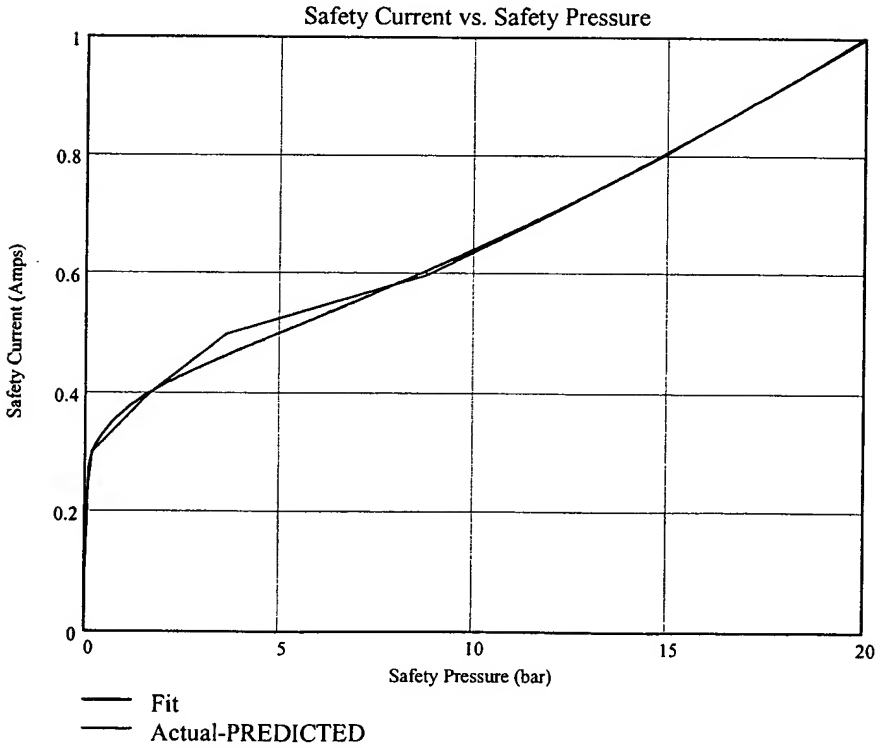
E.C.Sandstrom

Characteristic Equation:

$$i(P) = c1 + \frac{c2}{1 + P} + c3 \cdot x + \frac{c4}{0.0001 + P^3} + c5 \cdot x^2$$

Sample Equation with Coefficients:

$$i(P) := 0.426 - \frac{0.15}{1 + P} + 0.017 \cdot P - \frac{1.768 \cdot 10^{-5}}{0.0001 + P^3} + 6.033 \cdot 10^{-4} \cdot P^2$$



safety.mcd

Software Calibration - Overview

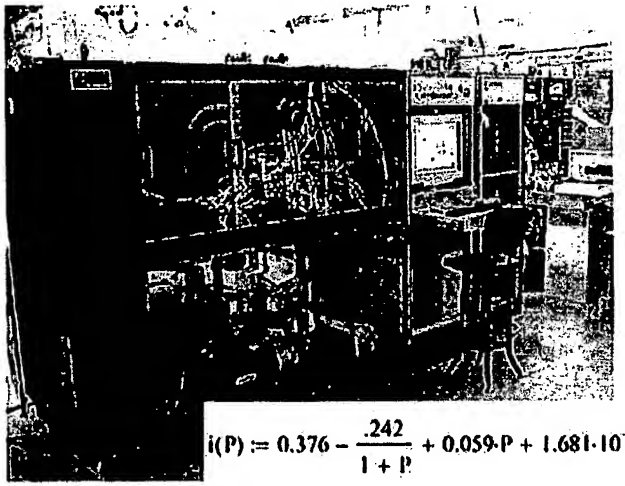
- Electronic calibration is made possible by integrated electronics (TCU)
- Electronic calibration allows
  - Increased accuracy of proportional functions
    - Improved control
    - Improved fuel economy
    - Improved driveability
  - Reduced cost

Software Calibration – How it Works

Characteristic Equation Coded into Vehicle Software

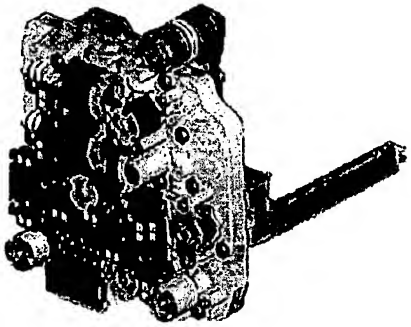
$$i(P) = c1 + \frac{c2}{1 + P} + c3 \cdot P + c4 \cdot P^2 + \frac{c5}{P^3 + 0.0001}$$

BW Tester Calculates Coefficients During EOL Test

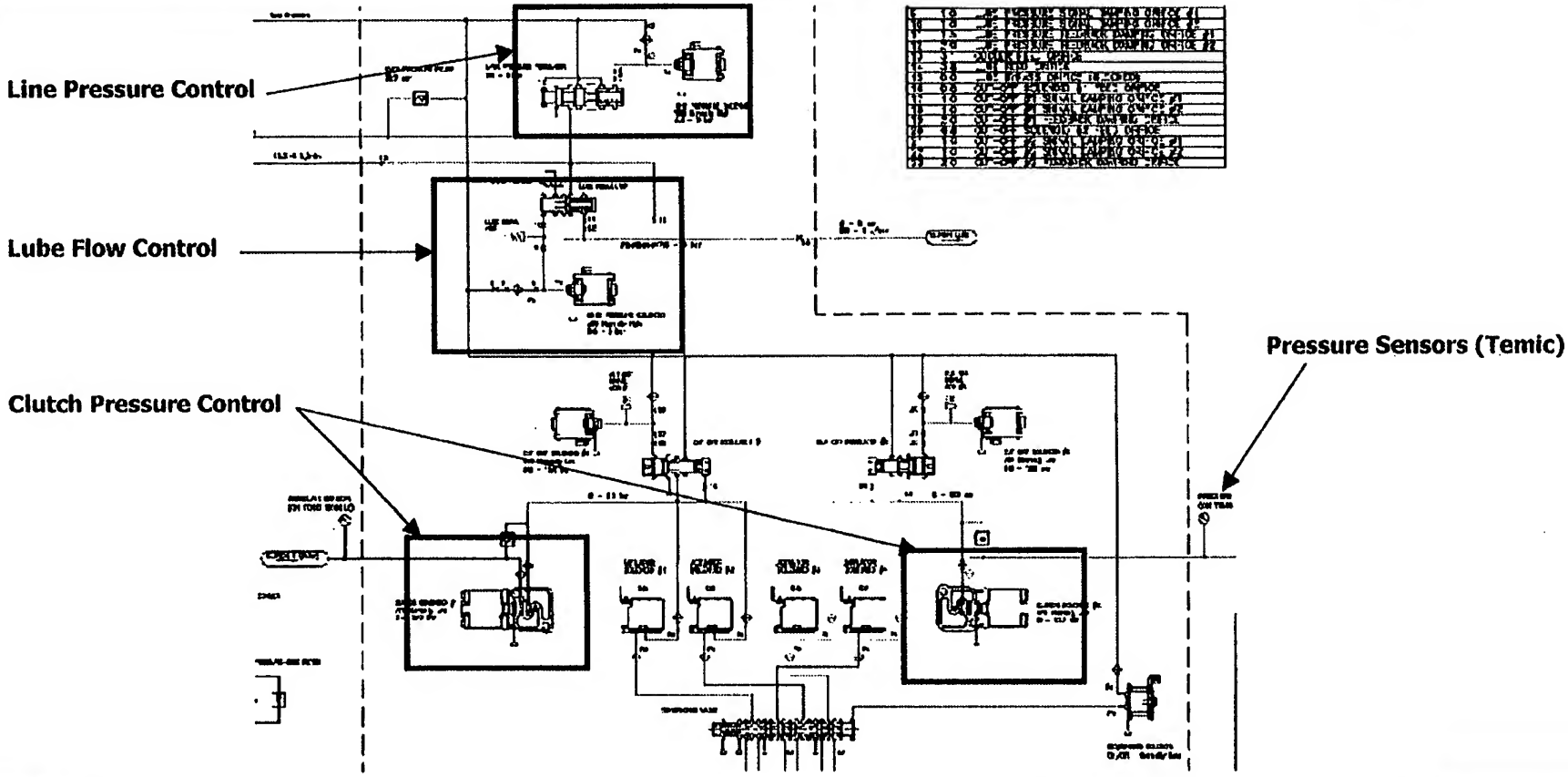


$$i(P) := 0.376 - \frac{.242}{1 + P} + 0.059 \cdot P + 1.681 \cdot 10^{-5} \cdot P^2 - \frac{7.328 \cdot 10^{-9}}{P^3 + 0.0001}$$

Calibration Data Written to TCU Memory during BW EOL Test



Software Calibration – What We Calibrate Electronically



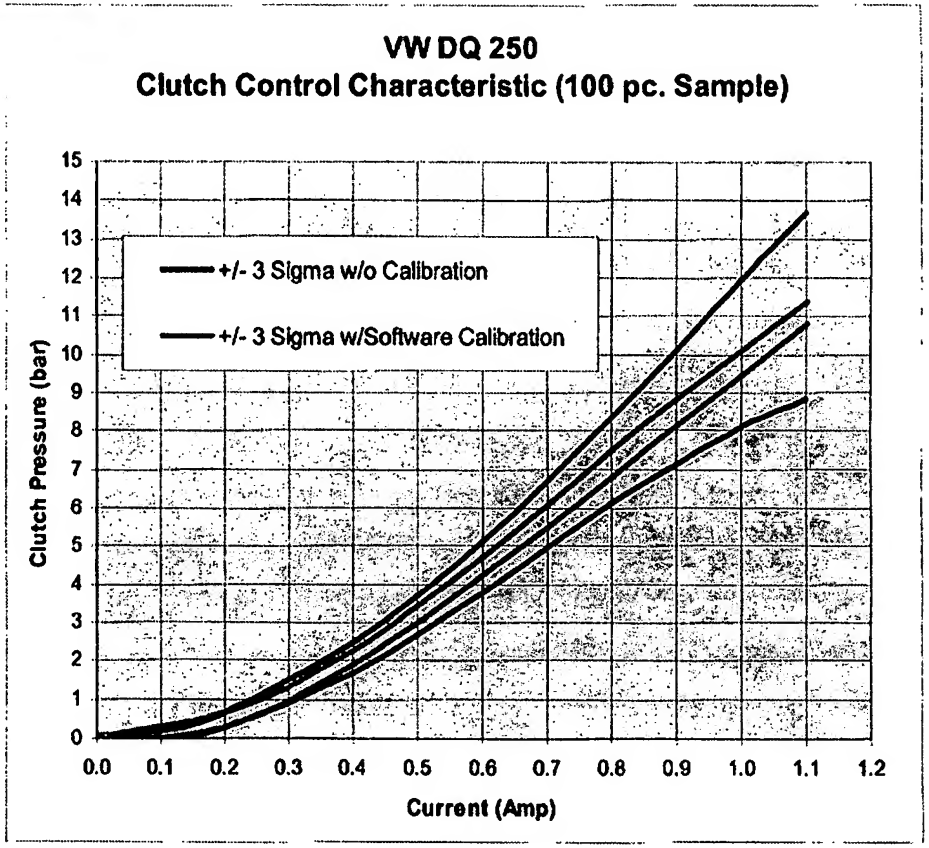
Software Calibration – Results

Characteristic Equation for Clutch Control

Characteristic Equation $i(P) = c1 - \frac{c2}{1 - P} + c3 \cdot P + c4 \cdot P^2 + \frac{c5}{P^2 + 0.0001}$

Sample Equation with Coefficients:

$$i(P) = 0.376 - \frac{.242}{1 - P} - 0.659 \cdot P + 1.68 \cdot 10^{-4} \cdot P^2 - \frac{7.128 \cdot 10^{-9}}{P^2 - 0.0001}$$



Reference:D:\Program Files\MathSoft\Mathcad 8 Professional\Template\units.MCD

VW Clutch Pressure Calibration

E.C.Sandstrom

data := READPRN("clutch.prn")

i_data := data$^{\langle 0 \rangle}$

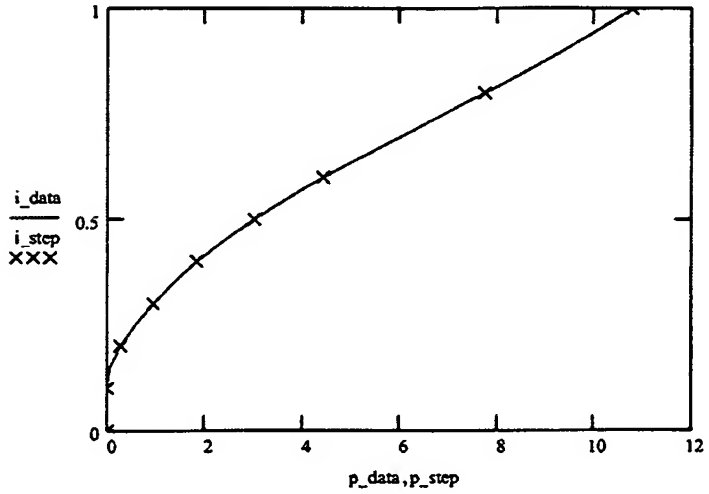
p_data := data$^{\langle 1 \rangle}$

step_data := READPRN("clutch_step.prn")

i_step := step_data$^{\langle 0 \rangle}$

p_step := step_data$^{\langle 1 \rangle}$

k := 0.. rows(data) − 1



$$F(x) := \begin{pmatrix} 1 \\ \frac{1}{1+x} \\ x \\ x^2 \\ \frac{1}{0.0001 + x^3} \end{pmatrix}$$

n := rows(step_data) n = 9

i := 0.. n − 1

data := csort(step_data, 1)

$X := data^{\langle 1 \rangle}$ $Y := data^{\langle 0 \rangle}$ $S := linfit(X, Y, F)$

Least-squares fitting function:

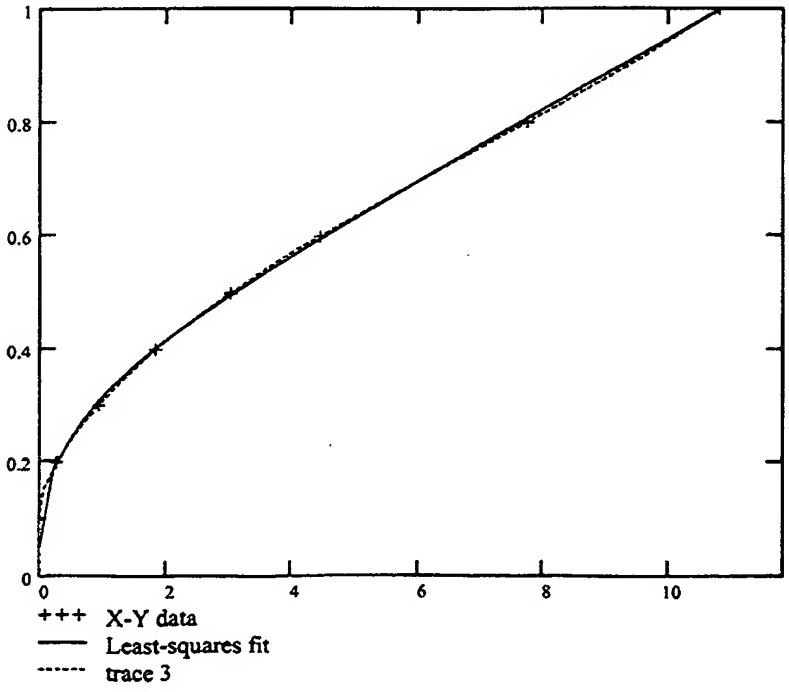
$fit(x) := F(x) \cdot S$

Sum of the squares of the residuals:

$$\sum_i \left(fit(X_i) - Y_i\right)^2 = 5.094 \times 10^{-3}$$

$npoints := 50$ $j := 0 .. npoints$

$$q_j := \min(X) + j \cdot \frac{(\max(X) - \min(X))}{npoints}$$



$P := 0, .1 .. 20$

EXHIBIT B

Attachments: vfs calibration coefficients_updated_12Nov02.xls.asc

vfs calibration coefficients_u...

-----Original Message-----
From: Sandstrom, Eric (PTC-Auburn Hills)
Sent: Tuesday, January 28, 2003 9:27 AM
To: 'Braun, Johannes'
Subject: RE: VFS Data

* PGP Decrypted Message

Hello Johannes,

Attached is the most recent calibration coefficient sheet that I have released. I don't see the serial numbers you're looking for in my list. Tulle has started generating the coefficients for spare VFSs, so the list may have come from Tulle. You might try contacting Jean-Pierre Alexandre.

Regards,

Eric

-----Original Message-----
From: Braun, Johannes [mailto:Johannes.Braun@volkswagen.de]
Sent: Tuesday, January 28, 2003 8:03 AM
To: 'Sandstrom, Eric (PTC-Auburn Hills)'
Subject: AW: VFS Data

Hello Eric,
sorry, the important information (calibration data) is missing of course.
The S.N. are 02-332-001 to 02-332-023.
Attached you 'll find some (incomplete) information about our visit in Tulle (what we intend to discuss).

Regards,

Johannes

-----Ursprüngliche Nachricht-----
Von: Sandstrom, Eric (PTC-Auburn Hills)
[mailto:ESandstrom@afs.bwauto.com]
Gesendet: Dienstag, 28. Januar 2003 12:58
An: 'Braun, Johannes'
Betreff: RE: VFS Data

Hello Johannes,

Are you looking for calibration coefficients or actual performance data?

Regards,

Eric

-----Original Message-----
From: Braun, Johannes [mailto:Johannes.Braun@volkswagen.de]
Sent: Tuesday, January 28, 2003 5:12 AM
To: 'BW Sandstrom, Eric'
Subject: VFS Data

Hi Eric,

you've sent an EXCEL sheet with VFS Data R7.3. I've seen it on a sheet of paper, but no one in Wolfsburg has the file. Can you send it once again?
Manufacturing date is 28th of november (332).

Regards,

Johannes Braun

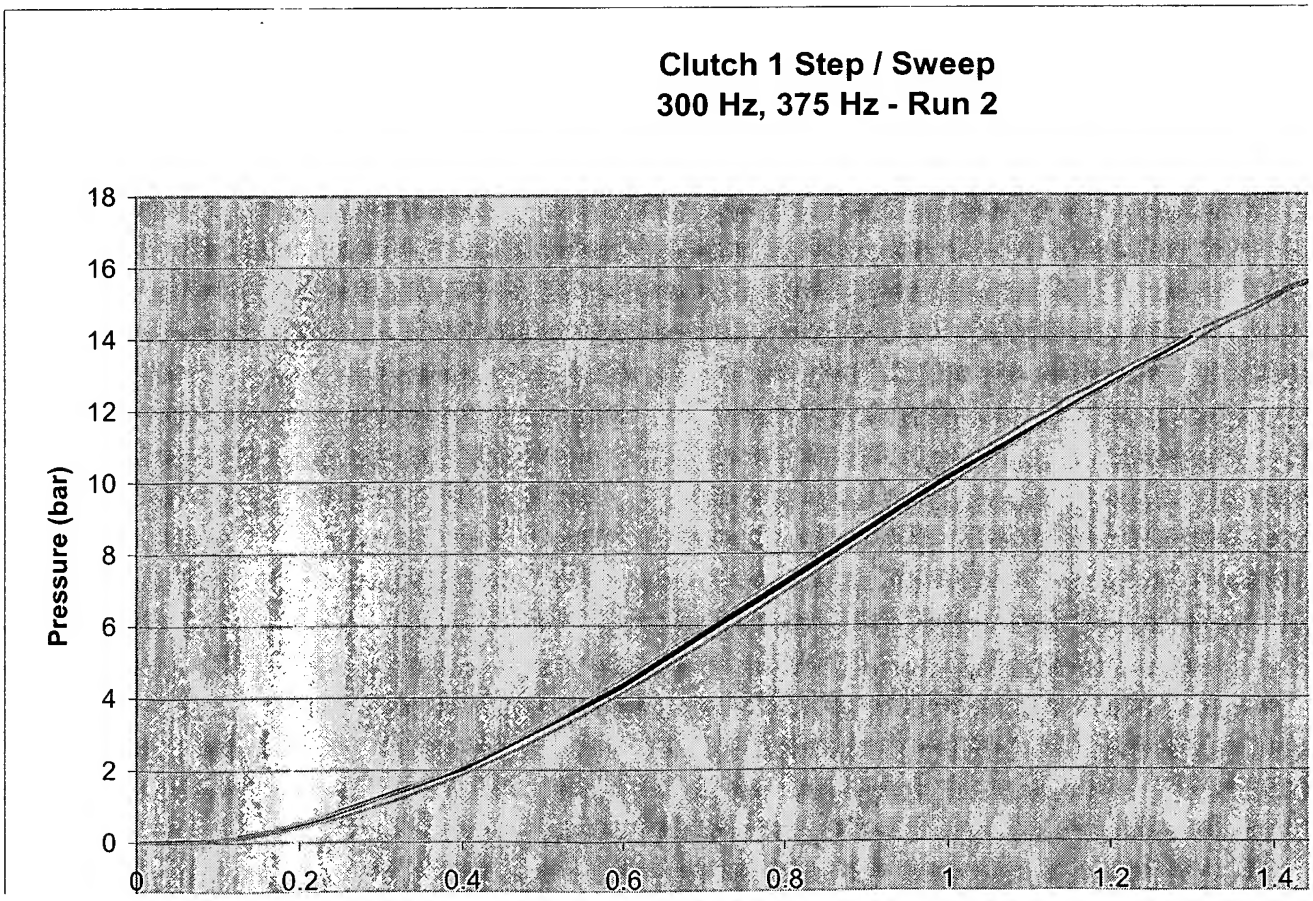
Volkswagen AG
EAGS, Brieffach 1765/1
D-38436 Wolfsburg
Tel.: +49-5361-936489
eFax: +49-5361-957-36489
Fax: +49-5361-932577
MailTo:johannes.braun@volkswagen.de

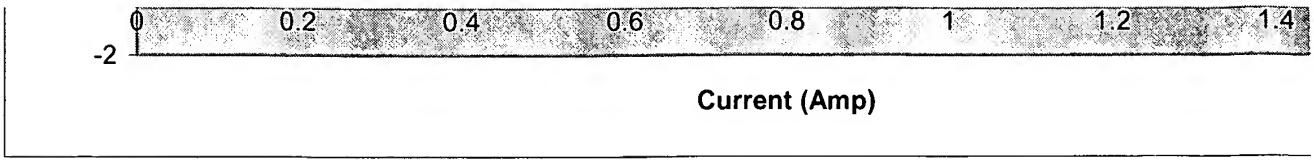
* PGP Decrypted Message
* vfs calibration coefficients_updated_12Nov02.xls
*
*

EXHIBIT C

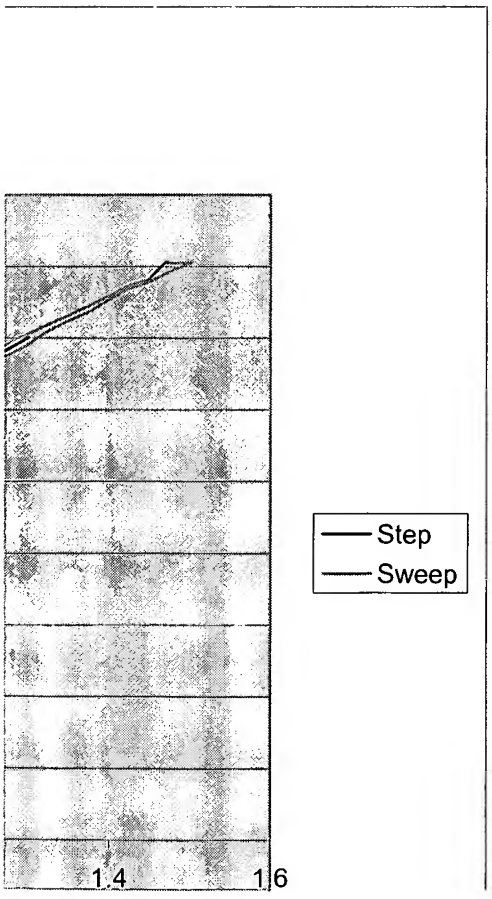
TestID	2076
Date	3/19/2003 16:36
Serial Number	Test D12B.001
Username	SA
User Comment	ps - 300 Hz driver - Run 2
Temperature	91.89306641
Test Duration	178.3240051
Setup Number	13
Setup Comments	High Frequency Test
Freq Mode	300
Line Freq	500
Clutch 1 Freq	375
Clutch 2 Freq	375
Lube Freq	600
ACC1 Freq	100
ACC2 Freq	100
ACC3 Freq	100
ACC4 Freq	100
CutOff Freq	300
Line Dither Amp	100
Clutch 1 Dither Am	100
Clutch 2 Dither Am	100
Passed Test	FALSE
Resp Filename	l_Mar1903;04.39.10p.xls#

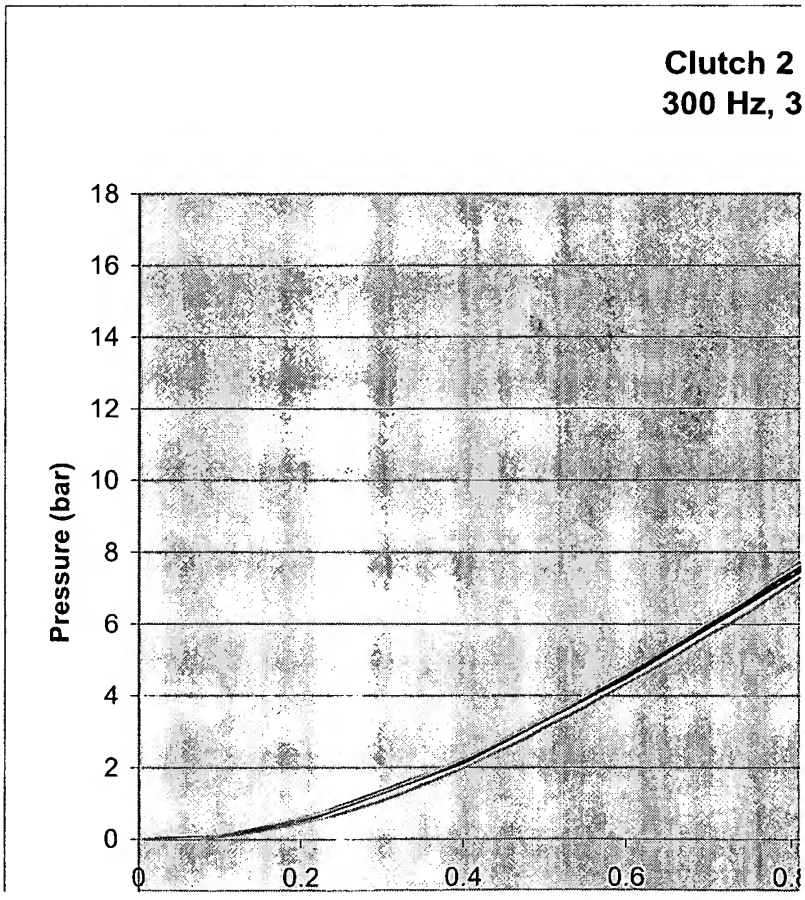
Line Sweep		Lube Swee
0.0023	20.81	
0.2504	19.47507	
0.4992	15.72799	
0.6992	11.06831	
0.7996	8.247039	
0.8495	6.806145	
0.902	5.323758	
0.9489	3.849872	
0.8994	5.217458	
0.8501	6.628895	
0.8	8.001616	
0.6999	10.83551	
0.4996	15.5557	
0.2497	19.36481	
0.0022	20.81623	

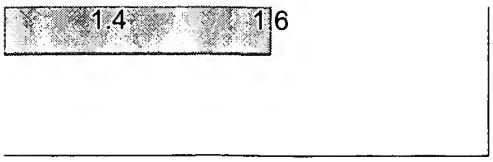


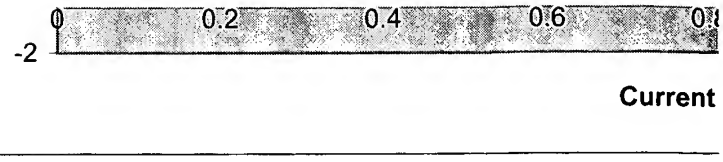

0
0.2
0.4
0.6
0.8
1
1.2
1.4
-2
Current (Amp)

:p	Clutch 1 Sweep		Clutch 2 Sweep		CutOff 1 Sv
	0.0036	0.002369	0.0039	-0.003973	
	0.1003	0.044199	0.0999	0.083053	
	0.2	0.428746	0.2001	0.473744	
	0.4001	1.994287	0.4004	2.11234	
	0.5992	4.277582	0.5994	4.475844	
	0.799	7.082444	0.7992	7.286934	
	0.9997	10.04107	1.0006	10.21594	
	1.3007	14.01582	1.301	14.07807	
	0.9999	10.10992	1.0001	10.27965	
	0.8	7.203893	0.7989	7.407373	
	0.6012	4.382535	0.6007	4.558999	
	0.4001	2.047143	0.4	2.16831	
	0.1999	0.468471	0.2002	0.520708	
	0.1001	0.080979	0.1	0.104936	
	0.0034	0.001191	0.0041	-0.008686	



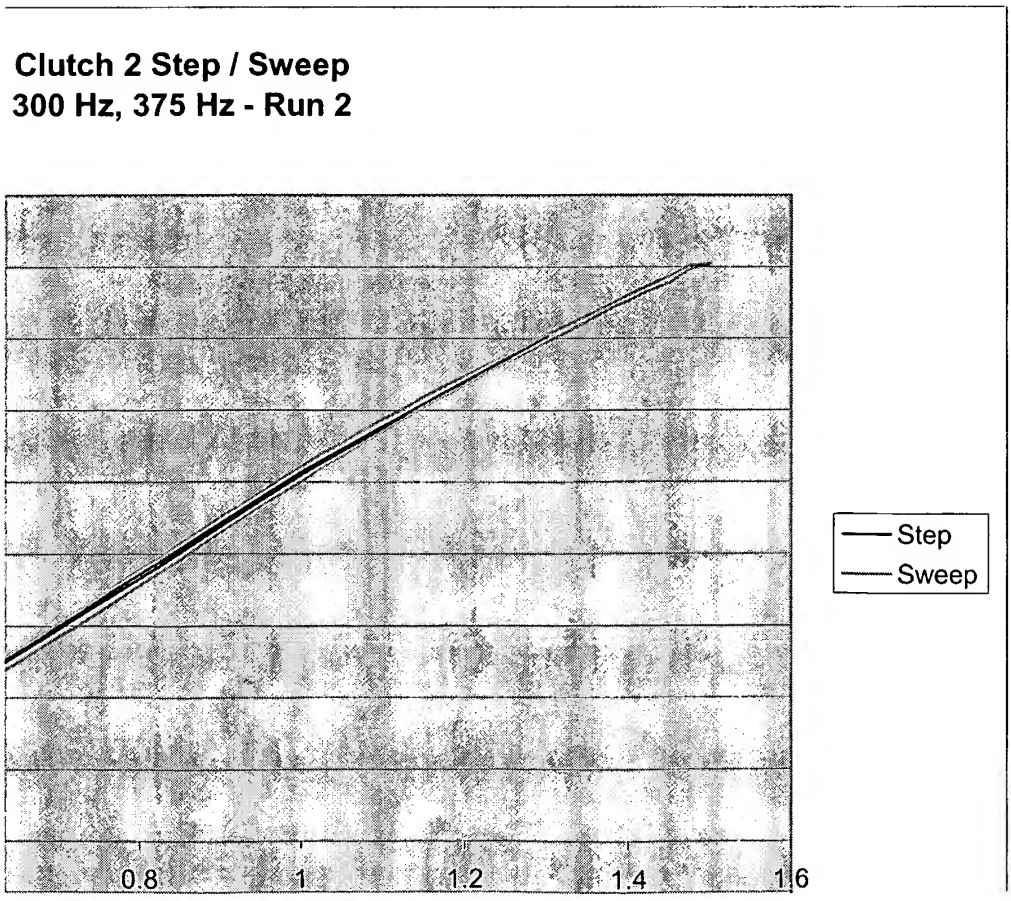


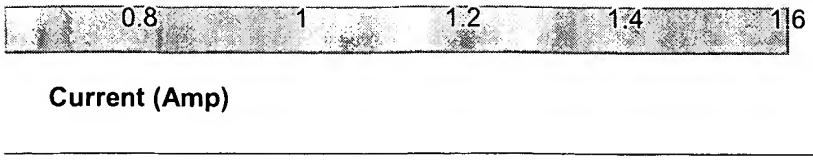




Current

weep	CutOff 2 Sweep	Line Sweep Check		Lube Swee
		20	20.09797	
		15	15.30043	
		10	10.22675	
		4	3.997075	
		10	9.937565	
		15	15.04794	
		20	20.01574	




0.8
1
1.2
1.4
1.6
Current (Amp)

ep Check	Clutch 1 Sweep Check		Clutch 2 Sweep Check		CutOff 1 Sv
	0	0.000433	0	-0.007507	
	2	2.009773	2	2.038023	
	5	4.834414	5	4.834553	
	10	10.14594	10	10.1077	
	15	14.86218	15	14.87309	
	10	10.16665	10	10.12807	
	5	4.910499	5	4.909206	
	2	2.049836	2	2.079685	
	0	-0.001418	0	-0.004983	

weep Check	CutOff 2 Sweep Check	Clutch 1 Regulation		Clutch 2 Re
		20.81	0.010786	20.81
		19.47507	0.008092	19.47507
		15.72799	0.002033	15.72799
		11.06831	-0.005458	11.06831
		8.247039	-0.009245	8.247039
		6.806145	-0.003859	6.806145
		5.323758	-0.004196	5.323758
		3.849872	0.00178	3.849872
		5.217458	-0.012275	5.217458
		6.628895	-0.006552	6.628895
		8.001616	0.002453	8.001616
		10.83551	-0.007983	10.83551
		15.5557	0.005147	15.5557
		19.36481	-0.002428	19.36481
		20.81623	-0.001334	20.81623

egulation	Line Cals		Lube Cals		Clutch1 Ca
0.006548	1	1.051697	1	5.88E-39	1
0.005622	2	-0.025081	2	5.88E-39	2
-0.005235	3	-0.000667	3	5.88E-39	3
-0.009275	4	-2.19E-10	4	5.88E-39	4
-0.006413					5
-0.012305					
-0.011716					
-0.000858					
-0.010706					
0.003266					
-0.007928					
-0.012305					
0.006043					
-0.007592					
-0.006666					

ıls	Clutch 2 Cals		CutOff 1 Cals		CutOff 2 Ca
0.358215	1	0.374329	1	11225656	1
-0.258041	2	-0.300522	2	65537	2
0.063557	3	0.057354	3	66974	3
0.000333	4	0.000689	4	262218	4
-9.48E-06	5	-6.71E-06	5	131334	5

als	Line Pressure Regulation	Line Repsonse	Lube Resp
262	15.58951 20.01574		
258			
773			
1030			
0			

onse | Clutch 1 Response | Clutch 2 Response | ACC 1 Res

;ponse 1	ACC 2 Response 1	ACC 3 Response 1	ACC 4 Res

;ponse 1	ACC 1 Response 2	ACC 2 Response 2	ACC 3 Res

ponse 2 ACC 4 Response 2 Sequencing Response 1 (Port 1) Sequencin

g Response 2 (Port 1) CutOff 1 Response CutOff 2 Response Leakage

Sequencing Response 1 (Port 5)	Sequencing Response 2 (Port 5)	Valve Body
		0
		1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
		12
		13
		14
		15
		16
		17
		18
		19

Info	Supply Pressures		Line Sweep Check Currents		Lube Swee
19000	0	21.13311	20	0.1776	
1	1	20.00236	15	0.5244	
1438	25	20.17818	10	0.7351	
74	5	19.15222	4	0.9405	
0	3	20.70639	10	0.7342	
6	26	9.867792	15	0.5241	
1	7	22.08644	20	0.1775	
6	27	19.98006			
1	31	20.11421			
2	29	20.6713			
1	33	22.1488			
5					
3					
6					
4					
171					
1					
1					
4					
2					

ep Check Currrents	Clutch 1 Sweep Check Currents		Clutch 2 Sweep Check Currents		Line Increm
	0	0.0046	0	0.0066	0.0026
	2	0.401	2	0.3918	0.0249
	5	0.6414	5	0.6283	0.0502
	10	1.0032	10	0.9889	0.075
	15	1.3734	15	1.3705	0.0999
	10	1.0063	10	0.9903	0.1249
	5	0.6423	5	0.6281	0.1501
	2	0.401	2	0.392	0.1749
	0	0.0043	0	0.0063	0.2002
					0.2262
					0.2498
					0.2748
					0.3004
					0.3245
					0.35
					0.3752
					0.3998
					0.4247
					0.4493
					0.4739
					0.4996
					0.5249
					0.5505
					0.5748
					0.5993
					0.6244
					0.6506
					0.6772
					0.701
					0.7227
					0.7494
					0.7741
					0.8009
					0.8231
					0.8496
					0.8739
					0.9005
					0.9245
					0.9498
					0.9738
					1.0007
					1.0237
					1.0484
					1.0758
					1.0998
					1.1257
					1.1507
					1.1746
					1.1994
					1.2003
					1.175

1.1481
1.1254
1.1002
1.0747
1.0503
1.0243
1.0001
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0.8741
0.8513
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0.7749
0.7503
0.7256
0.6998
0.6755
0.6501
0.6258
0.599
0.5744
0.5487
0.5251
0.4999
0.4752
0.45
0.4242
0.4001
0.3754
0.3502
0.3253
0.3
0.2735
0.2504
0.225
0.2001
0.1751
0.1501
0.1251
0.1001
0.0749
0.05
0.0251
0.0024

nented Step	Lube Incremented Step	Clutch 1 Incremented Step		Clutch 2 In
20.75925		0.0033	0.005147	0.0039
20.73198		0.0249	-0.001502	0.0248
20.67416		0.0499	0.002453	0.0501
20.60026		0.0752	0.010701	0.0752
20.50305		0.1001	0.044536	0.1001
20.35846		0.1249	0.118011	0.1249
20.23533		0.1501	0.199819	0.1501
20.08762		0.175	0.297029	0.1748
19.9038		0.1995	0.407621	0.1998
19.68969		0.2251	0.549101	0.2253
19.46127		0.2502	0.680482	0.2502
19.20229		0.2745	0.84477	0.2746
18.95249		0.2999	1.022273	0.3001
18.66516		0.325	1.210044	0.3249
18.32959		0.3488	1.418266	0.3495
17.97728		0.3742	1.633896	0.3745
17.58617		0.3999	1.872333	0.3998
17.17848		0.4242	2.111949	0.4243
16.79427		0.4487	2.366967	0.4493
16.34786		0.4749	2.628129	0.4749
15.88016		0.4991	2.910332	0.4988
15.37374		0.5244	3.203982	0.5247
14.86867		0.55	3.50933	0.5501
14.28583		0.574	3.816446	0.5739
13.67017		0.5999	4.143929	0.598
13.07201		0.6254	4.462407	0.6253
12.44019		0.6492	4.78139	0.6501
11.84136		0.6749	5.133197	0.6741
11.18909		0.7006	5.479534	0.6997
10.5688		0.7251	5.824271	0.7256
9.848939		0.7517	6.192742	0.751
9.01344		0.7754	6.545391	0.775
8.349467		0.7996	6.904857	0.8009
7.621866		0.8258	7.272403	0.8249
6.90891		0.8499	7.640369	0.8504
6.156312		0.8756	8.027779	0.8748
5.378296		0.9	8.397933	0.8986
4.693367		0.9231	8.76531	0.9245
3.941358		0.9481	9.145986	0.9492
3.136495		0.9738	9.511428	0.9749
2.561652		1.0021	9.863571	1.0017
2.244184		1.0246	10.23112	1.0237
2.161871		1.0511	10.60733	1.0514
2.139736		1.0751	10.94904	1.076
2.129636		1.1002	11.28418	1.1011
2.123324		1.1245	11.64398	1.1255
2.113224		1.149	11.96701	1.148
2.112719		1.174	12.30341	1.1731
2.103209		1.1991	12.61962	1.1998
2.102619		1.2232	12.94483	1.2227
2.108848		1.2474	13.25312	1.2481

2.102619	1.2778	13.54997	1.2748
2.108679	1.3017	13.83966	1.2986
2.119031	1.3216	14.15259	1.3251
2.127532	1.3483	14.46576	1.3488
2.137632	1.3765	14.74351	1.3763
2.154128	1.3964	15.02201	1.3988
2.199914	1.4232	15.36312	1.4223
2.340215	1.4508	15.56402	1.4507
2.813808	1.477	15.88015	1.4741
3.529963	1.5024	16.10798	1.4978
4.504839	1.5034	16.11345	1.5012
5.516579	1.4687	16.09779	1.4748
6.282979	1.4495	15.62723	1.4483
7.030359	1.426	15.47271	1.4226
7.735656	1.3959	15.12494	1.3983
8.461658	1.3733	14.88044	1.3734
9.159801	1.3482	14.61111	1.3481
10.06263	1.3217	14.34633	1.3239
10.68814	1.2974	14.08584	1.2965
11.37223	1.2733	13.79969	1.2756
11.96736	1.2507	13.49981	1.2507
12.61702	1.2241	13.21357	1.2239
13.21863	1.2013	12.91924	1.1995
13.72353	1.1772	12.6075	1.1758
14.29762	1.1473	12.29853	1.1495
14.88533	1.1277	11.9782	1.1264
15.42247	1.0989	11.64954	1.1002
15.88807	1.0753	11.29538	1.074
16.36579	1.0514	10.97513	1.0509
16.78922	1.0246	10.62652	1.0237
17.22317	1.0016	10.2636	0.9991
17.64391	0.975	9.91508	0.9748
18.008	0.9508	9.55654	0.9517
18.36974	0.9263	9.196317	0.9255
18.68174	0.8989	8.822626	0.899
19.02328	0.8747	8.462067	0.8761
19.29732	0.8494	8.082738	0.8511
19.56597	0.8263	7.706018	0.8251
19.78639	0.7992	7.333927	0.7999
19.9846	0.7737	6.969664	0.7742
20.18491	0.749	6.621307	0.7505
20.37083	0.7265	6.249638	0.7254
20.51071	0.6992	5.880829	0.6993
20.6192	0.6742	5.536092	0.6751
20.72348	0.6503	5.191607	0.6497
20.78307	0.6255	4.842157	0.6247
20.81261	0.6011	4.50592	0.6014
	0.5746	4.168758	0.5752
	0.5498	3.855498	0.5501
	0.5252	3.527089	0.5259
	0.501	3.234365	0.5009
	0.4747	2.934235	0.4752

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0.4005	2.124574	0.4003
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0.3493	1.64551	0.3501
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0.1748	0.393986	0.1748
0.1503	0.276998	0.1504
0.1247	0.177768	0.1252
0.0998	0.098064	0.1
0.075	0.042347	0.075
0.05	0.016004	0.0501
0.0249	0.006325	0.0249
0.0032	-0.002176	0.004

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